

# IFSAR Simulation using the Shooting and Bouncing Ray Technique

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## Abstract

Interferometric Synthetic Aperture Radar (IFSAR) is a technique that allows an automated way to carry out terrain mapping. IFSAR is carried by first generating a SAR image pair from two antennas that are spatially separated. The phase difference between the SAR image pair is proportional to the topography. After registering the SAR images, the difference in phase in each pixel is extracted to generate an interferogram. Since the phase can only be measured within  $2\pi$  radians, phase unwrapping is carried out to extract the absolute phase for each pixel that will be proportional the local height. While IFSAR algorithm is typically applied to measurement data, it is useful to develop an IFSAR simulator to develop a better understanding of the IFSAR technique. The IFSAR simulator can be used in choosing system parameters, experimenting with processing procedures and mission planning. In this paper we will present an IFSAR simulation methodology to simulate the interferogram based on the shooting and bouncing ray (SBR) technique.

SBR is a standard ray-tracing technique used to simulate scattering from large, complex targets (Ling, Chou and Lee, IEEE Trans. Antennas Propagat., Feb. 1989). SBR is carried out by shooting rays at the target or scene. At the exit point of each ray, a ray-tube integration is done to find its contribution to the total field. A fast algorithm has been developed for the SBR for simulating SAR images of complex targets (Bhalla and Ling, IEEE Trans. Antennas Propagat., July 1993). In the IFSAR simulation, we build upon the fast SAR simulation technique. Given the antenna pair configuration, radar system parameters and the geometrical description of the scene, we first simulate two SAR images from each antenna. After post processing the two SAR images, we generate an interferogram. Phase unwrapping is then performed on the interferogram to arrive at the desired terrain map.

We will present results from the SBR-based IFSAR simulator. The results will include terrain map reconstruction of urban environments. The reconstruction will be

compared to the ground truth to examine the fidelity of the simulation. We will also investigate the effect of multi-bounce scattering in urban environments on phase unwrapping and reconstruction.